CHILDREN AND HORTICULTURE: CONSTRUCTION AND EVALUATION OF ILLUSTRATED HORTICULTURAL TEACHING AIDS

by

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Forward

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Introduction:

Within horticultural (plant science/biology) curricula in the elementary school class, concepts such as plant anatomy, plant growth and development, and plant propagation need to be taught. Illustrated horticultural teaching aids were developed to aid the teacher and student in understanding these three concepts.

Although numerous teaching techniques for conveying plant science knowledge in the elementary classroom exist, few implement hands-on experiments with illustrated terminology and concepts. The elementary school teacher's understanding of horticulture may be improved through use of programmed illustrated teaching aids. Effective communication of knowledge from teacher to student may be increased with pre-planned horticultural procedures. Teaching horticultural concepts in grade schools is beneficial to children understanding life cycles, responsibilities, and gaining an interest and appreciation for nature.

The objectives of this study were (1) to design and investigate the effectiveness of utilizing eight illustrated horticultural teaching aids in fourth grade classes, (2) to develop an instrument to measure the effectiveness of these teaching aids in increasing the student's comprehension of basic horticultural knowledge, and (3) to compare basic horticultural knowledge (B.H.K.T.) scores by sex, school, and treatment (teacher assisted, self-directed, and control).

Literature Review:

Organized horticultural activities became integrated in American public schools during the late 1800's to train children in food production

and life responsibilities (1,2,3,4). In Europe, Gang (1) stated that German school gardens were established to give children a place to spend both work and leisure time learning about and enjoying trees, flowers and herbs. Miner (5) outlined the philosophy behind the children's garden at the Brooklyn Botanical Garden in 1914. He observed that "children can learn to get along with people, respect the rights and property of others, and to assume responsibility for the jobs that must be done."

Harbeck and Marcuccio (6) reported that between 1836 and 1844 the McGuffy Reader Series, written for children, contained descriptive literature on "the beauties and wonders of nature with occasional precise scientific explanatory notes. Children literally began their reading life with flowers, play companions and stars." Osterhout (3) reported that nature study is especially suitable for children as "children are natural investigators and enjoy experiments of all kinds, especially experiments with things which are alive."

Tuan (7) stated that as mechanization advances and urbanization grows, fewer American children experience the kind of intimacy with nature that existed in an earlier period. Williams and Hermann (8) stated that three positive benefits to children in horticultural activities are: (1) training in food production, (2) awakening an interest in nature's laws and (3) planning garden activities.

Hill (9) noted that children in the elementary school setting are capable of learning to: observe, classify, measure, inquire, infer and hypothesize. Using these skills, children must be assisted in their learning and in deciding what should be learned. He implied that elementary school learning should build skills and concepts which enable

children to cope more effectively with the objects, forces and events which comprise their environment.

Harbeck and Macuccio (6) have stated that science instruction in modern American elementary schools is faltering. Ottley (10) concluded that the readability of fourth grade science books were far too difficult. Williams and Hermann (7) reported that much of the science in elementary classrooms is textbook orientated with little scientific investigation. Newport (11) suggested that the science class should be an attempt to develop an attitude of inquiry.

Butts (12) indicated that self-discovery; i.e., free opportunity to perceive, was most effective with some external direction to help children focus their attentions on the involved relationships. Gross (13) identified two themes for the concern of total child development. The first is active learning from concrete experiences, the other is symbolization of that experience through sensory means. Firlik (14) noted that learning will occur more easily if children are allowed to see and handle materials and draw her/his own conclusions. Piaget (15) observed that intelligence is an active process which develops through interaction between the child and her/his world..

The effective display of materials for interaction is vital to promote learning as Firlik (14) outlined, for some children learn quickly from textbooks, other understand a concept only after they have seen it demonstrated and still others learn best through their five senses.

Newport (11) concluded that a major objective in science learning is to develop an understanding of the interaction between living things

and their environments. He suggested that growing plants and conducting simple experiments be used to develop interest for leisure time activities with children.

Hedges and MacDougall (2) tested the efficacy of programmed science material at the fourth grade level, coupled with an investigation of the influence of the individual performance of children of simple science experiments as they completed framed sections of the programmed materials. They found that achievement of those fourth grade children using the programmed method did significantly better than those taught by the conventional textbook methods. They also found that children who are allowed to actively participate in performing laboratory experiments have a greater proficiency in the solution of simple problems. Students having some direct contact with experimentation reported the highest degree of liking for science class, but those that only read about the experiments shifted their reaction to distinct dislike for science class.

Allen (16) reported that elementary school students exhibit an overwhelming enthusiasm for science classes in which they are case in the role of active learners. She compiled a set of science activities associated with seasonal changes, calendar events and topics including projects with living things, i.e., growing herbs in flower pots. Elementary school children found excitement in hands-on experiences that afford them an opportunity for personal involvement in the topics being studied, and especially enjoy those activities which present challenges and problem solving situations.

Numerous horticultural programs are aimed at providing children with hands-on experiences through self-discovery (17,18,19,20). Using

several horticultural materials (21,22,23) as a guide; this study was conducted to prepare horticulture related learning projects and evaluate their effectiveness.

Method

Subjects:

The study consisted of 59 female and 45 male children enrolled in fourth grade classes in each of two public schools in a city of 21,000. Each school had three fourth grade classrooms.

Children from both schools were approximately 50% white, 40% black, and 10% other races, and were predominately of middle socioeconomic levels from agricultural and military family backgrounds. One fourth grade class from each school was randomly assigned to each of the following treatments: (1) horticultural teaching aids, teacher supervised, (2) horticultural aids, self-directed, and (3) control, normal classroom curricula.

"Grow-N-Green" Horticultural Teaching Aids:

Eight illustrated teaching aids were prepared to show step-by-step procedures in completing basic horticultural activities (Appendix A). Horticultural terminology was blended with actual hands-on experiments covering horticultural knowledge in (1) plant structures, (study of seed and plant parts), (2) plant propagation, (vegetative reproductive techniques), and (3) plant growth and development, (observing physiological changes from germination to fruiting). These three concepts were introduced using eight aids that were selected by teachers as

appropriate supplementation to a fourth grade science curriculum (Table I).

Each of the eight procedures was handwritten and drawn on paper with drafting pens and ink. A copy of the "Grow-N-Green" series was made for every student and teacher in the experimental groups. Unfamiliar terminology was defined and phoenetic spelling supplied for difficult words. A list of required materials was supplemented with cartooned drawings of the items. The procedures were written in large print using "ball and stick" lettering similar to that found in fourth grade reading materials. The content, lettering, and wording were reviewed by educational specialists.

Teacher Guides:

Eight Teacher Guides were developed to accompany the "Grow-N-Green" teaching aids. They were designed for the fourth grade teacher with limited horticultural experience and supplied information on specific terminology, materials, detailed activity descriptions, and questions and answers for the student (Appendix B).

Basic Horticultural Knowledge Test:

Since a standardized test to measure the level of horticultural knowledge of fourth grade children does not exist, the fifteen item Basic Horticultural Knowledge Test was developed (Appendix C). Five multiple choice questions were graphically represented for each of the three concepts covered in the "Grow-N-Green" teaching aids. One point was given for each correct answer, the maximum scores obtainable was fifteen. Children in all six classrooms were read the Basic Horticultural

Knowledge Test as they read silently. The students were tested during the first week of the study and again after the eight illustrated procedures were complete.

Preliminary Testing:

The "Grow-N-Green" activities, Teacher Guides, and Basic Horticultural Knowledge Test were pre-tested by the principal, teachers and fourth grade students at a different school. After specific recommendations were suggested regarding wording, lettering, and test question order, necessary alterations were made and final copies printed.

Activity and Test Administration:

Students in two classrooms completed the eight procedures with the teacher's supervision; two classrooms completed the illustrated procedures individually; and two classrooms served as the control, continuing with normally scheduled curricula. All six classrooms were pre-tested with the Basic Horticultural Knowledge Test during the first week of the research study. Eight "Grow-N-Green" activities were scheduled, two per week for four weeks (Table I). After the experimental groups completed the teaching aid series, all six classrooms were post-tested with the Basic Horticultural Knowledge Test, and evaluation forms filled out by the students and teachers in the four experimental groups (Appendix D).

Research Design and Data Analysis:

A pre-test - post-test design was utilized for the research study. The collected data were analyzed by t-Test, F-test, Duncan's Multiple Range Test and Item Analysis. A t-Test was performed on differences between all pre- and post-test scores. An Analysis of Variance was

computed with the main effects being, teaching method, school, and sex. A Duncan's Multiple Range Test was performed on the main treatment and interaction means. The Item Analysis was computed for the pre- and post-test scores on the Basic Horticultural Knowledge Test.

The following statistics were computed based on children's scores from the Basic Horticultural Knowledge Test:

(1) Total score = Plant Structures + Plant Propagation + Plant Growth and Development.

(2) Total net scores = Post-test - Pre-test total scores.

(3) Plant Structures net score = Post-test - Pre-test structure scores.

(4) Plant Propagation net score = Post-test - Pre-test Propagation scores.

(5) Plant Growth and Development net score = Post-test - Pre-test Growth and Development scores.

The subjective analysis of the teaching series was based upon the comments and opinions of the teachers and students. Using the treatments in the experimental groups, a prepared form for both the teachers and the fourth grade students served as the evaluation for the teaching series (Appendix D).

Results and Discussion

Basic Horticultural Knowledge Test Scores:

An Item Analysis was computed on the pre- and post-test scores of the Basic Horticultural Knowledge Test providing the Discrimination Index and Kuder Richardson values.

For the pre-test Basic Horticultural Knowledge Test scores, eight of the fifteen test items were below the accepted Discrimination Index minimum level of 0.20 and the Kuder Richardson value was below the accepted level of 0.80. This indicates that eight of the items were too difficult and the students were guessing on the majority of the test questions. This was an expected outcome due to the unfamiliarity and complexity of the subject matter.

For the post-test scores, thirteen out of the fifteen test questions had a Discrimination Index above the 0.20 acceptable level and had a Kuder Richardson value of 0.76. Two of the test questions were still too difficult even after the "Grow-N-Green" teaching series, thus keeping the Kuder Richardson value below acceptable standards. These two test questions covered the plant growth and development, and plant propagation concepts, both complex areas of study and difficult to grasp with such limited exposure. The two items should be examined and rewritten.

As shown in Table II, the scores of children significantly increased ($p < .0001$) between pre- and post-test scores for all concepts. The 22% increase would indicate that children learned horticultural concepts. However, the initial scores of 40% which increased to 62% on post-test scores, also indicate that urban children are inadequately taught concepts of plant structures, plant propagation, and plant growth and development. The post-test scores are considered below standard and would be expected to improve had the study period been longer.

These net scores (Δ) were then subjected to an Analysis of Variance with the main effects being teaching method (teacher assisted, self-directed, and control), school, and sex.

Teaching Method:

The teaching methods were highly significant for all concepts; Basic Horticultural Knowledge Test, $F(2,92) = 64.09$, $p < .0001$; Plant Structures, $F(2,92) = 7.07$, $p < .0001$; Plant Growth and Development, $F(2,92) = 28.03$, $p < .0001$; and Plant Propagation, $F(2,92) = 22.29$, $p < .00001$. The net scores (Δ) associated with each teaching method for each concept were subject to a Duncan's Multiple Range Test ($\alpha = .05$). As shown in Table III, the teacher assisted method produced significantly ($p < .05$) higher scores than the self-directed method for all concepts. All scores associated with the self-directed method were significantly higher than the control, children who were not exposed to the "Grow-N-Green" teaching aids.

Horticultural knowledge can be increased if the teacher presents the "Grow-N-Green" aids as a supplement to the existing elementary science curriculum. However, it can also be seen that the self-directed method, although not as effective as the teacher supervised, can be used as an educational way of structuring free time in the elementary classroom.

School Effects:

Scores of children in the two schools were similar ($p < .05$). However, the analysis generated significant F-ratios for the teaching method x school interaction in the plant structure concept, $F(2,92) = 12.80$, $p < .0001$; and Total Basic Horticultural Knowledge Test score, $F(2,92) = 7.07$, $p < .0001$.

As shown in Table IV, the net Basic Horticultural Knowledge Test scores of the teacher assisted aids were significantly ($p < .05$) higher than the self-directed or control group scores. The scores associated

with the teacher assisted treatment at school #2 were significantly higher than those of the same treatment at school #1. The self-directed group at school #1 did significantly better than the self-directed group at school #2 and both control groups. The control group at school #2 did not differ significantly from the self-directed group.

All plant concept net scores showed similar trends; however, only plant structure concepts were significant. For the plant structure concepts, the teacher assisted students at school #2 scored significantly higher than other treatments. Self-directed and teacher assisted treatments at school #1 were similar. These scores were significantly ($p < .05$) higher than the self-directed scores at school #2 and both controls.

The concepts related to plant structures were covered in six of the eight "Grow-N-Green" teaching aids. This repetition of plant parts, combined with interest in the material may have caused the significant scores in the plant structure concepts.

The indication of a teacher effect on the scores of both of these concepts, stresses the value in providing the Teacher Guides for each "Grow-N-Green" teaching aids. These guides serve to assist the teacher that is less knowledgeable in horticultural skills in being able to present the material in a manner that is both educational and interesting to the student. As true with any body of knowledge, teacher enthusiasm and communication skills will have an effect on the amount of knowledge conveyed.

Sex Differences:

Within all sections of the Basic Horticultural Knowledge Test, boys and girls scored similarly in teacher assisted classes (Table V). However, boys scored significantly higher in self-directed study than girls in the plant structure concepts. No differences occurred between boys and girls in the plant growth and development concepts or total Basic Horticultural Knowledge Test scores. Similarly, in the control groups, boys and girls scored equally on the Basic Horticultural Knowledge Test concepts. The plant propagation concepts scores for girls and boys within the teaching methods were similar. As shown in Table V, considerable overlapping of scores exist between the treatment x sex interaction (D.M.R.T. $\alpha = .05$).

Recommendations:

The "Grow-N-Green" horticultural teaching aid series was found to be applicable additions to the biology program in the fourth grade curriculum.

Two improvements to the teaching aid series are recommended: (1) "Taking a Leaf Cutting" activity was unsuccessful for the students and the teachers. Procedure #2, propagating the Begonia leaf should be replaced with a plant having greater survivability, such as a Jade plant; (2) a scavenger materials list should be compiled for the teacher giving ideas for accumulating materials for plant activities, such as saving milk containers for planting seeds. Most materials necessary for the "Grow-N-Green" aids are easy to obtain and inexpensive.

The student indicated an interest in outdoor gardening activities, including planning the garden, flower and vegetable identification, planting seeds and harvesting. Activities including gardening, taxonomy, conservation and ecology would be appropriate additions to the "Grow-N-Green" teaching series.

The Basic Horticultural Knowledge Test requires further testing to standardize it. The "Grow-N-Green" teaching series is available for use by writing the author.

Table I

Relationships Between Horticultural Activities and Educational Concepts

Week	Activity	Concepts		
		Structures	Growth & Development	Propagation
1	"What is a Seed?"	X		
1	"Let's Sprout Seeds!"	X	X	X
2	"Germinating Seeds"	X	X	X
2	"Taking a Stem Cutting"	X		X
3	"Transplanting Seedlings"	X	X	
3	"Let's Sprout an Avocado!"			X
4	"Let's Repot it!"		X	
4	"Taking a Leaf Cutting"	X	X	X
		6	5	5

Table II

Basic Horticultural Knowledge Pre- and Post-Test (B.H.K.T.)[z] Scores.

Test Concepts	Pre-test	Post-test	TΔ	Pr < T
Plant Structures	2.3	3.1	5.05	.0001
Plant Growth & Development	1.5	2.7	8.69	.0001
Plant Propagation	2.2	3.5	7.26	.0001
Total B.H.K.T. Scores	6.1	9.3	8.94	.0001

[z]Maximum score on the B.H.K.T. = 15 points, 5 points per concept.

Table III

Change in Scores Between Pre- and Post-Tests of Children in Teacher Assisted, Self-Directed and Control Group Study.

Teaching Method	Structures	Growth & Development	Propagation	Total B.H.K.T.[z]
Teacher Assisted	1.91 a[y]	2.40 a	2.20 a	6.51 a
Self-directed	0.69 b	1.00 b	1.03 b	2.72 b
Control	-0.21 c	0.29 c	0.66 c	0.74 c

[y]Means in columns with the same letter designation are not statistically different from one another at $p < .05$ (D.M.R.T.).

[z]B.H.K.T. = Basic Horticultural Knowledge Test.

Table IV

Change in Scores Between Basic Horticultural Knowledge Pre- and Post-Tests for Children in Teacher Assisted, Self-Directed and Control Group Study at Two Schools

Teaching Method	School	Structures	Growth & Development	Propagation	Total B.H.K.T.[z]
Teacher Assisted	1	1.28 b[y]	2.28 a	2.11 a	5.67 b
Teacher Assisted	2	2.59 a	2.53 a	2.29 a	7.41 a
Self-directed	1	1.37 b	1.11 a	1.26 a	3.79 c
Self-directed	2	-0.37 c	0.88 a	0.75 a	1.50 d
Control	1	-0.53 c	0.37 a	-0.16 a	-0.32 e
Control	2	0.20 c	0.20 a	0.33 a	0.73 d e

[y]Means in columns with same letter designation are not statistically different from one another at $p < .05$ (D.M.R.T..

[z]B.H.K.T. = Basic Horticultural Knowledge Test.

Table V

Change in Scores Between Basic Horticultural Knowledge Pre- and Post-Tests of Boys and Girls in Teacher Assisted, Self-Directed and Control Group Study

Teaching Method	Sex	Structures	Growth & Development	Propagation	Total B.H.K.T.[z]
Teacher Assisted	girl	2.00 a[y]	2.25 a	1.85 a b	6.10 a
Teacher Assisted	boy	1.80 a	2.60 a	2.67 a	7.07 a
Self-directed	girl	0.38 b c	0.86 a	1.33 b c	2.92 a
Self-directed	boy	1.14 a b	2.21 a	0.57 c d	2.61 a
Control	girl	0.17 c d	0.38 a	0.33 d	-0.50 a
Control	boy	-0.63 d	0.22 a	-0.25 d	0.72 a

[y]Means in columns with the same letter designation are not statistically different from one another at $p < .05$ (D.M.R.T.).

[z]B.H.K.T. = Basic Horticultural Knowledge Test.

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Appendixes

Appendix A

"Grow-N-Green" Activities

Grow-n-Green

Seeds - What are they?

Where do Seeds come from?

A Seed can come from a flower, like the Sunflower that has over 2,000 seeds, OR Seeds can come from fruit, like Apples, Avocado and Corn, OR seeds can hide inside Pods (Beans + peas) and nutshells.

Seeds can be tiny, like Petunia flower Seeds, OR as large as a Coconut. (now that's a big seed!)

There are many different kinds of seeds, and each one has its own special color, shape and size. (just like you!)

How does a Seed grow into a Plant?

A Seed is great, it contains almost everything that's needed to grow into a plant. All we have to do is add water and give it a warm place to sprout. (GERMINATE) And the Seed will do the rest.

This is what happens.

outside of a seed



The SEED COAT protects the seed from the environment (insects, weather, etc.) When the seed is given the proper conditions (water + warmth) the seed will swell and the seed coat will split open.

Inside the Seed



Endosperm (en' dō spurm) this is where the food and nutrients are stored.

Emboryo (em' brī ō) The little plant that gets food from the endosperm and emerges as the seedling. (A seedling is a young plant.)

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Let's do Something .....

Materials you need:



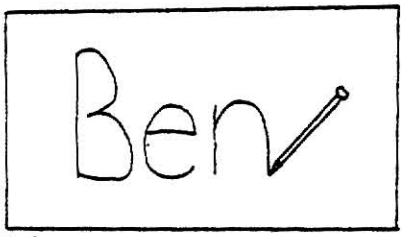
PAPER



PENCILS + PENS

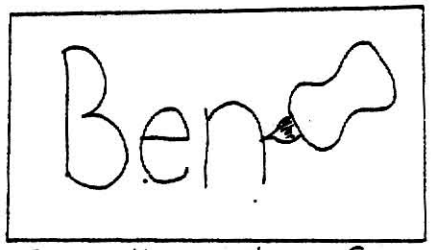


Step 1*



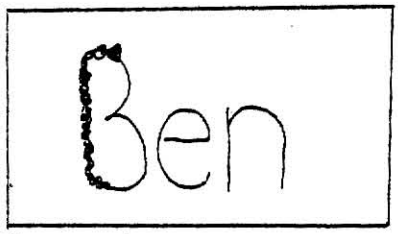
Write your name in the center of the paper.

Step 2*



Trace the outline of your name with glue.

Step 3*



Decorate your name with seeds.

Step 4*



glue and label some of your favorite seeds on the edge of the paper.



Let it dry overnight → then hang it up!

GAS 1982

Grow-n-Green

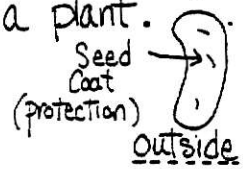
Sprouting A Seed

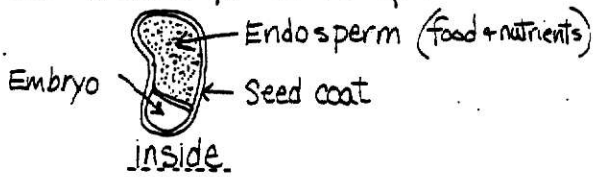
What is a seed for?

Planting and watching a seed sprout and develop is an exciting miracle to experience. The process by which a seed comes to life is called GERMINATION!

What is inside a seed?

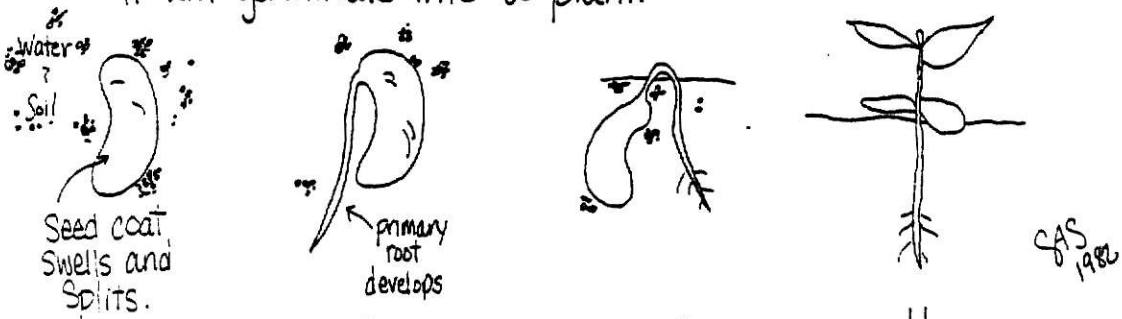
A seed has everything inside needed for it to grow into a plant.





What happens when a seed germinates?

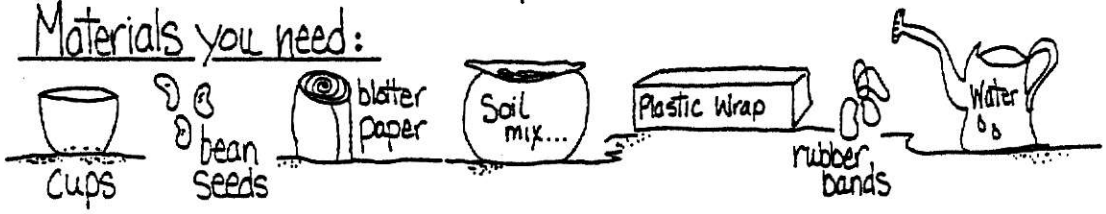
Most seeds do not have a top or bottom. You can plant a seed in any direction and the roots will always grow down and the stem will grow up toward the light. So, when a seed is given water and a warm place to sprout, it will germinate into a plant.



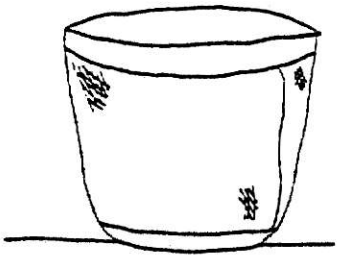
Grow-n-Green

Let's Sprout Seeds!

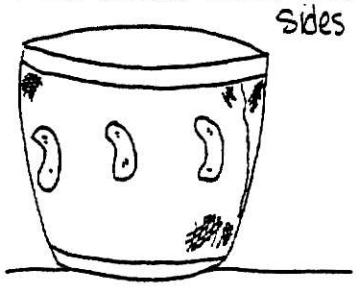
Materials you need:



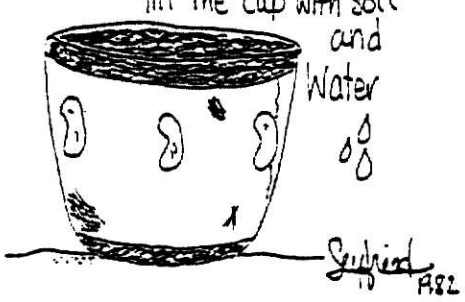
Step 1.
Line the cup with moist blotter paper.



Step 2.
Place several seeds around the sides of the cup.

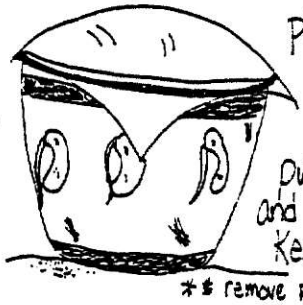


Step 3.
fill the cup with soil and Water



Step 4.
Cover the top with plastic and secure it with a rubberband.

put cup in a warm and dark place. Keep moist.



** remove plastic when seed sprouts.

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Grow-n-Green

Let's germinate Seeds!

Now that we know what a seed is and what it can become if it is given water and warmth. Let's consider how we can sow a whole bunch of seeds at once.

We can sow (plant) seeds outside and inside.

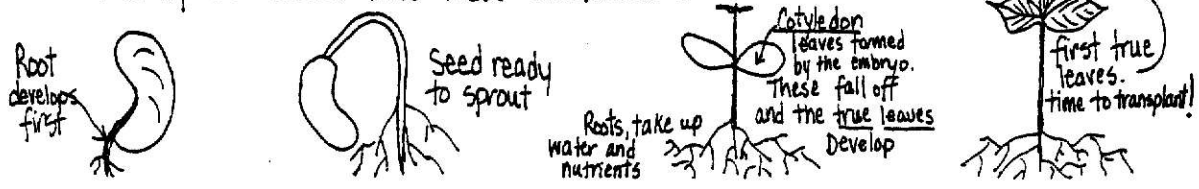
When it's cold and wintery outside, we can plant seeds inside and have seedlings (young plants) in just weeks. And in the spring we can plant seeds directly into the soil, and enjoy flowers and vegetables all summer.

This is how we start growing plants indoors.

We are going to germinate (germ in ate) flower seeds called Marigolds. The seeds will be planted in rows, in a container called a flat. And like the bean seeds we sprouted, the marigold seeds will need water and warmth in order to germinate (sprout).

What happens when the seeds pop up through the soil?

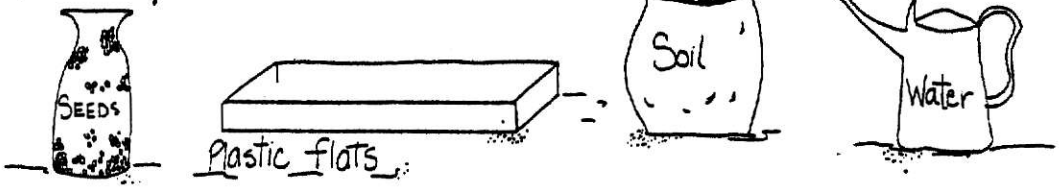
When the seeds germinate and start to grow, the young new plant is called a seedling. Seedlings require water (like seeds) but they need something most seeds don't, SUNLIGHT! When seedlings develop their first true leaves it time to transplant them into new containers!



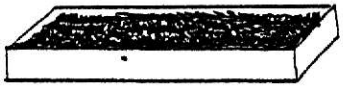
Grow-n-Green

Let's Germinate Seeds!

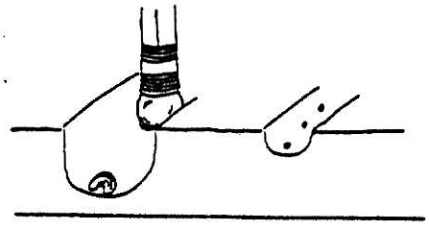
Materials you need:



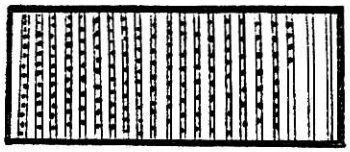
Step 1. fill the flat with soil.



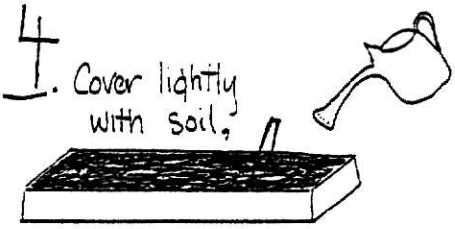
Step 2. Make rows with a pencil. (the larger the seed, the deeper the row!)



Step 3 Sprinkle the seeds evenly in the rows. (the larger the seeds, the farther apart!)



Step 4. Cover lightly with soil,



and keep the flat! MOIST!!

Step 5. Label the rows. name of plant; date; your name.

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Grow-n-Green

TAKING STEM CUTTINGS

☆ Learning to propagate plants ☆

Why do we propagate plants?

We propagate (prop a gate) plants to increase our plant supply. (QUICKLY)

How do we PROPAGATE plants?

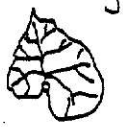
There are several ways to propagate plants, we can collect seeds and plant them, OR we can take cuttings, OR we can Graft, which is a very complex technique. (and many more) But, today we are going to take some stem cuttings.

What is the difference between Stem, leaf and leaf-petiole cuttings.

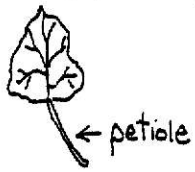
Stem Cuttings:



Leaf cutting



Leaf-petiole cutting



Stem cuttings can include the petioles (the leaf stalks) But are ALWAYS CUT just below the NODE.

The Node is the point where the leaf (or petiole) is attached to the stem.



← Roots will develop here.

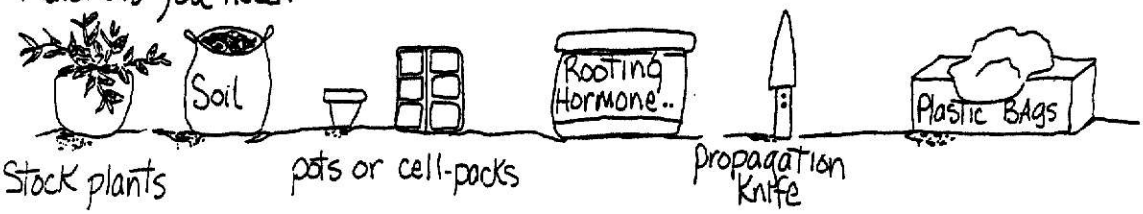
We cut just below the node because they will grow Roots faster.

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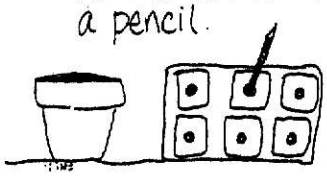
Taking A Stem Cutting (propagation technique)

Materials you need:

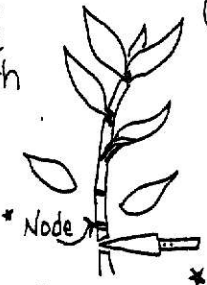


STEP. 1.

fill the pots or cell-packs with soil and poke a hole in the center of each with a pencil.



STEP. 2.



Cut a piece of plant stem just below the node (3"-5") and pinch off the lower leaves.

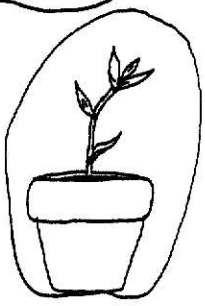
* A node is the point where the leaf is attached to the stem!
* Dust end of cutting with rooting hormone.

STEP. 3.

Place the cutting in the hole and gently press the soil to hold the stem firmly.



STEP. 4.



Water and cover stem cutting and pot with a plastic bag.

Keep it moist!

* after it has developed roots, remove the plastic bag.

Grow-n-Green

TRANSPLANTING SEEDLINGS



☆ After the seeds in the flat germinate and the first true-leaves develop it is time to transplant them.

With delicate seedlings, we need to be gentle!

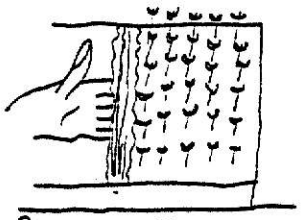
A seedling is the young plant that emerges from the seed.

We must be very careful when we handle seedlings so we do not bruise the stem or break the root system.

How should I pick up a Seedling?

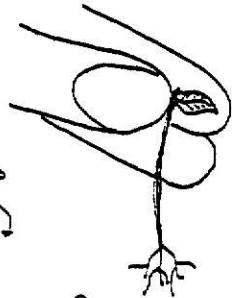
When we remove a bunch of seedlings from a flat, we scoop them gently from the bottom. Never pull the seedling from the flat by its leaves or stem.

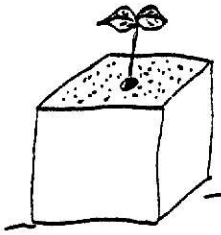
To remove one seedling from the bunch and transplant it, hold it by the leaves. Try not to hold it by the stem, they bruise easily.



Scoop a Bunch...







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Select one and transplant. (hold it by the leaves)

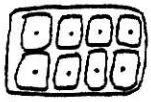
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Transplanting Seedlings

Materials you need:


flat of seedlings




plastic containers

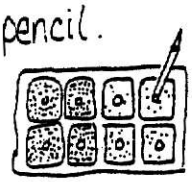

lables



pencils

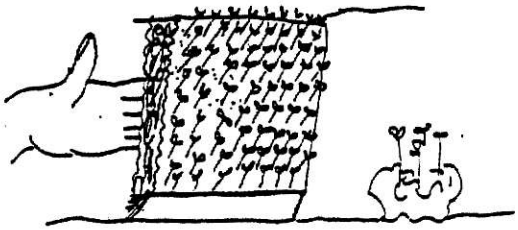
Step 1.

fill the cell-paks with soil and poke a hole in the center of each with a pencil.



Step 2.

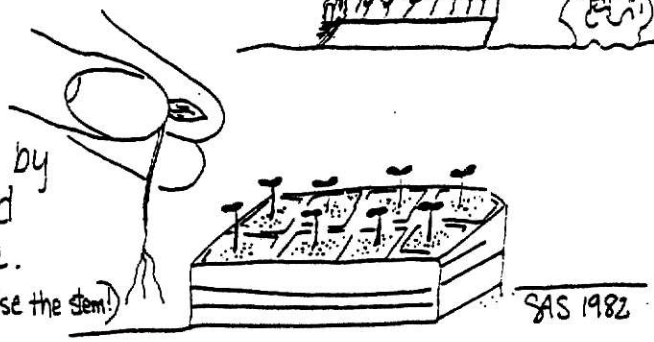
Scoop the seedlings and soil from the bottom and gently raise them out of the flat.



Step 3.

Hold the seedling by the true leaves and place it in the hole.

(we hold it by the leaves so we don't bruise the stem!)



Gently firm the soil to hold the seedling upright.

Water and keep moist (not soggy)

Grow-n-Green

Let's Repot It!

Why do we repot plants?

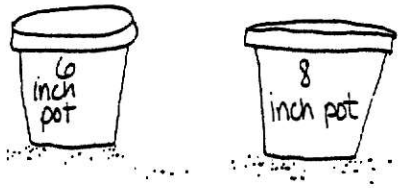
We repot a plant to give its roots more room to grow.

What does Root-bound mean?

We say a plant is root-bound when the roots have no more room to grow in its pot. So, we need to repot a plant if it is root bound.

What size pot?

Use a slightly bigger pot But no more than 2" inches bigger.



Why do we put gravel, clay chips or pebbles in the bottom of the pot?

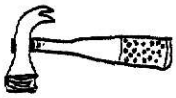
We need to layer the bottom of the pot with gravel, chips or pebbles to insure proper drainage.
Too much water can be as hard on a plant as too little.

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Grow-n-Green

Let's Repot it!

Materials you need:


Hammer


broken clay pieces


Clean pots


plant to repot



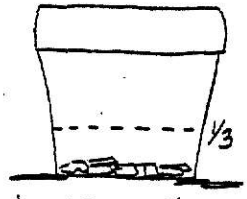
Step 1.

Break a clay pot into 1" pieces.



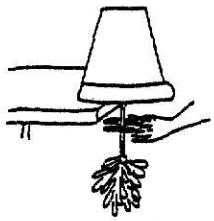
Step 2.

Place the pieces of broken clay in the bottom of the pot. then, fill ⅓ of the pot with soil.



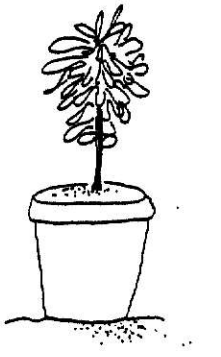
Step 3.

Tap the pot on the edge of a table. Be sure to hold the plant, so it doesn't fall.



Step 4.

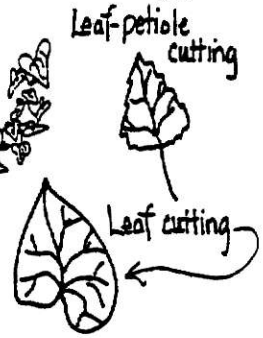
Place the plant in the pot and add soil. Be sure the plant is centered in the pot.



Water....

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Grow-n-Green



TAKING A LEAF CUTTING

☆ Learning to PROPAGATE ☆

What does PROPAGATE mean?

The word PROPAGATE, pronounced prop-a-gate, means to grow new plants from stem cuttings or leaf cuttings.

Why do we PROPAGATE plants?

We propagate plants to increase our supply. By removing 4 or 5 cuttings (either stem cuttings, leaf or leaf petiole cuttings) from a plant and giving them the proper conditions, they will root and develop into new plants. So, from one plant we now have 4 or 5 new ones.

What does a cutting need to grow roots? (proper conditions)

Like all plants, a cutting needs water to grow, (the soil should be moist not soggy) it also needs sun-light. (* seeds can sprout in darkness, but once they pop up they also need light)

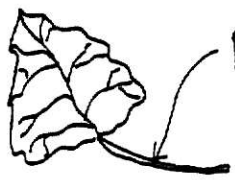
How many ways can we Propagate plants?

- STEM CUTTING
- LEAF cutting
- leaf petiole cutting
- leaf-bud
- planting seeds
- Grafting

Why are we Taking Leaf and Leaf-petiole Cuttings?

By taking cuttings we can increase our plant supply Quickly. But remember not all plants respond to these techniques.



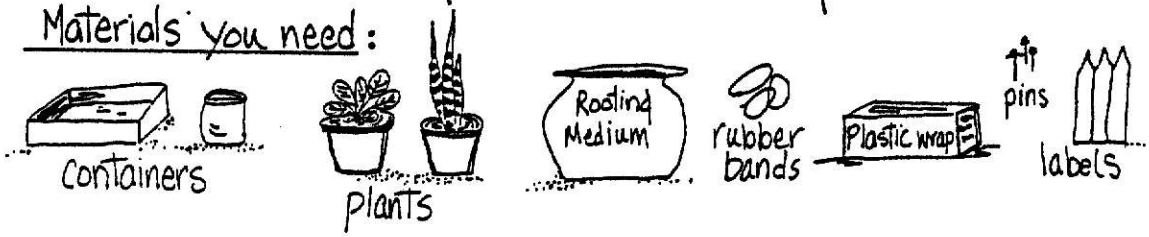


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Taking A Leaf Cutting

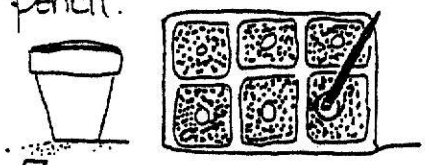
Materials you need:



Procedure 1. Propagating an African Violet.

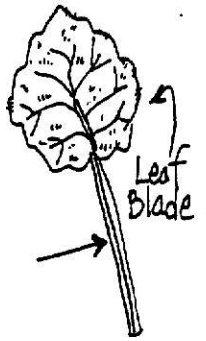
Step 1.

Fill containers with soil and poke a hole in the center of each with a pencil.



Step 2.

Cut a mature leaf from the plant, the stem or petiole still attached.



Step 3.

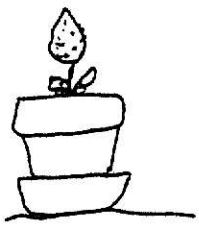
Place the petiole in the hole and firm the soil around it.



Step 4.

Set the pot in a saucer and water thoroughly.

* Water carefully. African Violets do not like their leaves wet.
* Keep the saucer full of water.



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Taking A Leaf Cutting

Procedure 2: propagating a Begonia rex

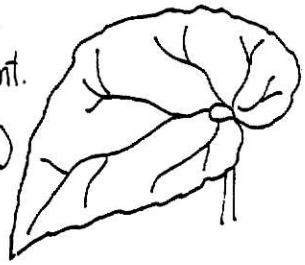
Step 1.

fill a shallow container with rooting medium.



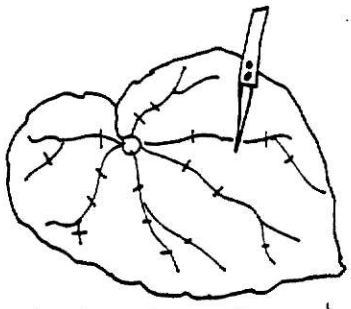
Step 2.

Remove one leaf from the Begonia plant. (cut off the petiole so the leaf will lie flat)



Step 3.

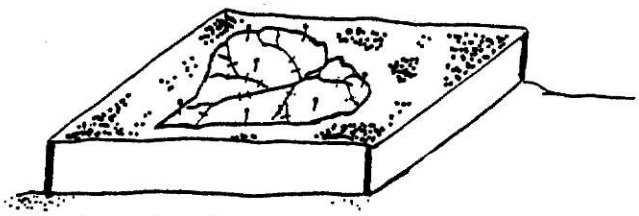
Turn the leaf over and make small cuts through the veins. (3 or 4 cuts per large vein)



* make the cuts on the underside of the leaf.

Step 4.

Place the leaf (rightside up) in the rooting medium and secure the leaf into place with pins.



* New plants will spring up where the veins were cut. The old leaf blade will gradually disintegrate.

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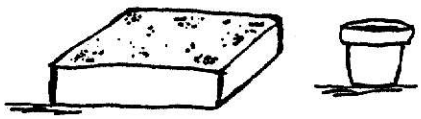
Grow-n-Green

Taking A Leaf Cutting

Procedure 3. propagating a Sansevieria

Step 1.

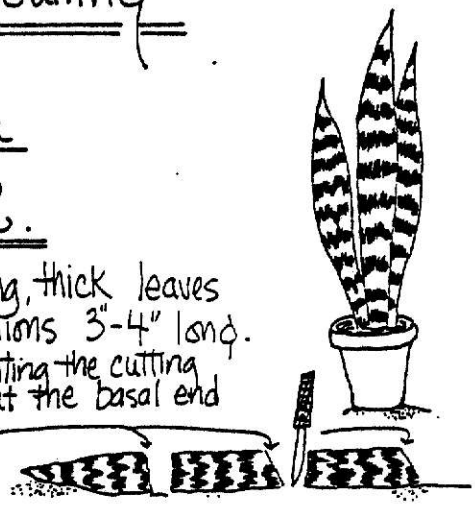
fill containers with Sand



Step 2.

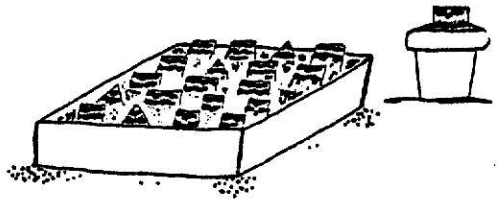
Cut the long, thick leaves into sections 3"-4" long.

☆ to avoid planting the cutting upside down, cut the basal end at a slant..



Step 3.

Insert the sections into the sand. Bury 3/4 of their length.



This is how the new plant will look.

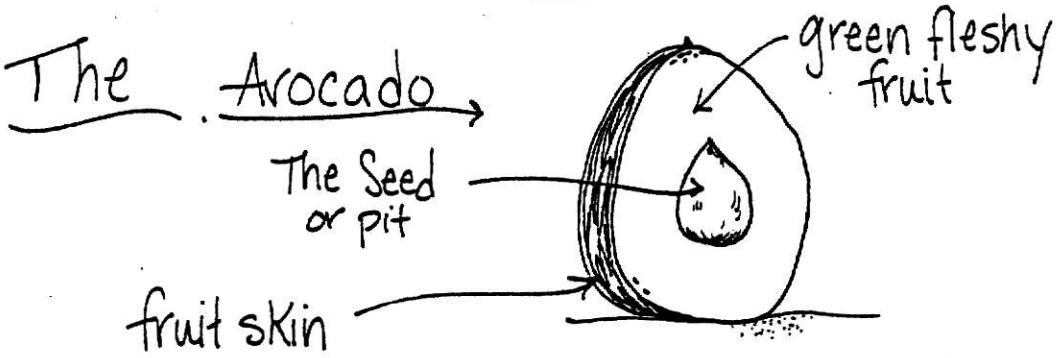


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Grow-n-Green



STARTING AN AVOCADO SEEDLING



The seed of an Avocado is in the center of the green fleshy fruit.
This seed can be germinated in water, and the seedling then transplanted to a pot to make a nice houseplant.
When the avocado becomes rootbound, we repot it into a slightly larger pot.

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Grow-n-Green

Sprouting an Avocado

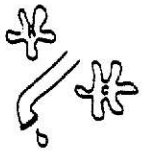
Materials you need:


Avocado pit

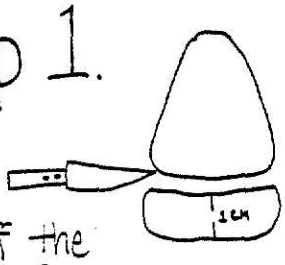

Knife


Plastic cups


toothpicks


water

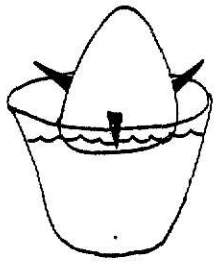
Step 1.



Cut off the bottom of the Avocado Seed (pit).

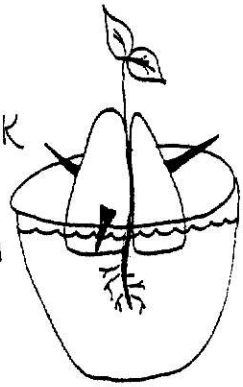
Step 2.

Insert toothpicks in Avocado seed, place in plastic cup. Fill cup with water.



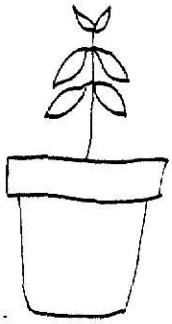
Step 3

Keep in a dark warm spot and make sure the seed has enough water.



Step 4

Transplant the avocado seedling into a pot with soil. Keep moist with water.



Appendix B

Teacher Guides

Grow-n-Green

Instructor's Guide

WHAT IS A SEED?

Brief Description

This activity introduces basic concepts of shape, size, and color.

Procedure

1. The amount and variety of seeds is important. Be sure to have enough seeds available for decorating and study.
2. On a sheet of construction paper, have the client write or print his/her name.
3. Trace the outline with glue and decorate with seeds.
4. The perimeter of the sheet may be decorated as well. Some of the seeds can be labeled with appropriate names.
5. Finished products can be displayed on a wall or door.

Suggested Materials

1. Seeds for observation and study: nuts, peach and plum pits, pinecones, avocado pits, coconuts.
   Seeds for decorating: flowers (e.g. celosia, marigold); vegetables (e.g. radish, tomato, beet); grains (e.g. wheat, milo); fruits (e.g. apple, orange, watermelon); others.
2. White glue (dries clear and non-toxic).
3. Colored construction paper (14" x 12").
4. Pencils, pens or crayons.

Special Considerations

This activity is effective for short term gratification. Let the client do as much as she/he can. If the client is unable to write his/her name, the instructor should guide the client's hand. If the client is confused, be very careful that the seeds are not ingested; (make sure seeds are chemical free in all cases). If the client is arthritic, glue one letter at at time (avoid the mess), and encourage the client to push one seed at a time to the glue. If the time period is short, you may adapt this activity to making small name tags.

Grow-n-Green

Instructor's Guide

WHAT IS A SEED? Page 2

Possible Goals

Physical: Fine motor, sensory awareness, hand-eye coordination.

Cognitive: Emphasis on seeds, becoming familiar with a wide variety of seed color, shape and size, to correlate a seed and where it comes from, stimulation of interest.

Emotional: Focus on physical steps of activity and realize personal expression in an art form.

Review Questions for Client

1. Describe the different colors and shapes of some seeds.
2. Why do you think some seeds have hard outer shells?
3. What does a seed do?

Answers

1. Brown, smooth, thin (watermelon)
   Rough (beet) etc.
2. The hard shell or seed coat protects the seed from the environment.
3. The seed, if given light, nutrients and water, will sprout into a plant.

Grow-n-Green

Instructor's Guide

LET'S SPROUT SEEDS

Brief Description

This activity should be checked daily; the development can be recorded on a simple chart. Germination should occur within 7-10 days.

Procedure

1. A cross-section of a seed or a detailed sketch should be available as you discuss the various seed parts and their importance in seed germination and seedling development.
2. Fresh, viable seed are imperitive for optimal germination.
3. The plastic cups are lined with blotter paper and filled with a soil mix.
4. Four or 5 seeds are evenly distributed between the blotter paper and the plastic side.
5. Moisten the soil with water; be sure that the seeds are adequately moist, but not water-logged.
6. Cover plastic cup with plastic wrap and secure with a rubber band or tape.
7. Observe the process of germination and water when necessary, keeping the seed moist at all times.
8. When the seed has sprouted, remove the plastic covering.

Suggested Materials

1. Bean seeds work nicely; they are large and easily handled.
2. Clear plastic cocktail glasses are unbreakable and lightweight.
3. Clear plastic wrap or parafin film.
4. Blotter paper.
5. 1:1:1 soil mix.
6. Watering can and water.

Special Considerations

The instructor should explain the different parts of the seed, and stress the importance of caring for a living thing. Discuss the needs of a seed, the importance of oxygen (O_2), water (H_2O), soil and nutrients. Explain how necessary light is for seedling development and plant life.

Grow-n-Green

Instructor's Guide

LET'S SPROUT SEEDS Page 2

Seed Coat - protective covering around seed flesh (embryo and endosperm).

Embryo - The life-giving part of the seed, without it there would be no new plant.

Endosperm - starch, nutrient and food storage inside seed.

Goals

Physical: Fine motor, hand-eye coordination, sensory awareness.

Cognitive: To stimulate an interest in seed germination. Prolonged gratification needs. Client will be asked to observe the development of seeds and answer questions for 10 days.

Emotional: Focus is on the physical steps of the experiment, and waiting for growth to occur. To better understand caring for a living thing and perhaps equate this to the client's own life.

Review Questions for the Client

Set up a simple chart dated daily for 2-3 weeks. Observe and write down the progress of the sprouting seeds.

1. Are the seeds being kept moist? Checking the soil daily?
2. How long did it take for the seed to germinate?
3. Once the seeds are sprouted, how long until they pop through the soil.

Answers

1. Yes, the seeds should be checked daily and kept moist.
2. 7-10 days.
3. 10-14 days.

Grow-n-Green

LET'S GERMINATE SEEDS

Brief Description:

This activity is appropriate for germinating large quantities of seeds.

Procedure

1. Fill the 11" x 24" plastic flat with soil, leaving approximately 2 cm at the top edge of the container. Press the soil gently with your hand or small board.
2. Make shallow trenches with the end of a label or pencil. The depth of the trench should vary with seed size. For example, a small tomato seed would be planted shallow and a large bean seed would be planted deeper (3 cm).
3. There are several ways to sow the seeds.
   a) Seeds can be scattered evenly over the top of the soil (in this case no trenches made).
   b) They can be distributed in the canals or trenches.
   c) The name of the client can be written in the soil and seeds be sprinkled in the canal. The seeds will germinate and spell out the name.
4. Cover seed with soil, if so indicated on package. Some seeds, like petunia, do not need to be covered at all. You do not want vine seeds settling too deep in the medium. Just as some seeds require light to germinate, like impatiens, others require continuous darkness like verbena. For many seeds, the light requirement has no effect on the germination. It is important to read the package or look up the information in a book.
5. Label the flat according to the seeds planted. If every row is different, indicate with a label.
6. Optional, cover the flat with plastic, creating a greenhouse effect.

Suggested Materials

1. Commercial plastic flats (11" x 22") egg cartons or other shallow containers that have drain holes.
2. Seeds, easy to germinate: flower--marigold and salvia; vegetable--beans and tomato.
3. Soil mix: 1:1:1 soil, peat, perlite
4. Seedling or plants that correlate with the seeds being germinated.
5. Water
6. Plastic wrap (optional)

Grow-n-Green

Special Considerations

This activity is especially suited for germinating large numbers of seeds. In an average commercial plastic flat, 750-1000 tomato seeds and 1000-1200 petunia seeds can be planted. When mixing the soil and filling the containers, we have found that moistening the soil makes it easier to handle. It is important to note if your seeds need sun or shade for germination. Do not cover the seeds with soil if it is not recommended.

* For spring flowers, sow seed in late February.

Possible Goals

Physical: Hand-eye coordination, gross and fine muscle movement.

Cognitive: To stimulate the client's interest in the life giving quality as they plant the seeds and observe them as they grow. To understand better the great quantities of plant materials grown every season.

Emotional, client self-esteem can be enhanced as the seeds germinate and grow.

Possible Review Questions

1. What kind of seed did you plant?
2. What does a seed need to germinate and grow?
3. What is the next step after the seeds germinate?

Answers

1. Marigold, tomato, etc.
2. Moisture (water), nutrients and warmth from the soil and oxygen.
3. When the sprouted seeds germinate and grow into seedlings, the next step is to transplant them into larger containers.

Grow-n-Green

TAKING A STEM CUTTING

Instructor's Guide

Brief Description

This is just one of the many propagation techniques used to increase your plant supply. If you desire to increase your plant stock or trim back a leggy plant, this activity can assist you in taking the proper cutting and preparing it for rooting.

Procedure

1. Fill the containers with mosit soil. Leave 2cm at the top of each container. Use the end of a pencil and poke a hole in the center of each container.
2. Have stock plants labeled and explain to the client what kind of plant they are using (foliage, house, desert).
3. Cut the stem with a sharp knife or scissor below the node. The entire cutting should be 3-5" long.
4. Gently remove the lower leaves, being careful not to injure the stem in the process.
5. Place the cutting relatively deep in the pot, so when the soil is pressed around the stem, it doesn't fall over (new roots will form up and down the buried stem).
6. Water the cutting thoroughly and cover the pot and plant with a plastic bag. The open end of bag should be tucked neatly under the pot.
7. Label the pot with the name of plant, date, propagator.

Suggested Materials

1. Insect free stock Plants

   Easy rooters:
   1. Spiders(chlorophytum comosum)
   2. Wandering jew (Tradescantia)
   3. Sedums
   4. Kalanchoe
   5. Ivy (Hedera helix)
   6. Swedish Ivy (Plectranthus australis) use rooting hormone

   Not Recommended
   1. Woody plants
   2. Ferns, easily propagated by division
   3. Rubber tree will root but is cumbersome because of its size.

2. Soil Mix--peat:sand:perlite 1:1:1 (the sand helps hold the cutting in place)
3. Pots or cell packs
4. Rooting hormone
5. Sharp propagation knife or scissors (clean & insect free)
6. Pencils and labels

Grow-n-Green

Instructor's Guide

Special Considerations

This activity should work well if you demonstrate as you explain the procedure. Another name for a cutting is called a slip, this term is one our grandmothers and grandfathers would find common. Depending on your client group, you may need to assist them in cutting the stem. There are adaptive tools made for special populations, scissors for example, are made with extra large handles for easy gripping. The stem cut should be made just below the node for faster rooting. Dusting the cut end of the slip with rooting hormone is optional, however it is recommended for swedish ivy.

Depending on group size, a production line (assembly line) can be set up. This is a good way to increase the social interaction during the activity.

Node - the part of the stem bearing the leaf
Slip - the stem cutting 3-5" long
Propagation - the manual act of reproducting a plant
Propagator - one who propagates

Possible Goals

Physical: improve fine motor control
develop eye-hand coordination
develop sensory copacities

Cognitive: develop a sense of curiosity about nature and plants

Emotional: decrease dependency
increase social interation, working within a group

Review Questions for the Client

1. What is a node?
2. What is a slip?
3. Why did you remove the lower leaves?

Answers

1. A node is the point where the leaf is attached to the stem.
2. A slip is another term for stem cutting.
3. The lower leaves are removed because that is the section planted in the pot and the leaves would get in the wax and rot.

Grow-n-Green

TAKING A STEM CUTTING

Instructor's Guide

Scavenger Materials List

1. Donated stock plants (local greenhouses)
2. Milk and egg catrons
3. Sand or soil from backyard (sterilize in 150^{0} oven for 1/2 hour)

Final Note

Careful handling of the stem cutting is essential in successful root development. It is very important that the stem cutting is not bruised or broken. To insure proper development hold the cutting gently.

Grow-n-Green

TRANSPLANTING SEEDLINGS

Instructor's Guide

Brief Description

This activity will help us understand when to transplant, how to remove several seedlings from a flat, how to pick up one seedling without injurying it, and the proper way to transplant seedlings.

Procedure

1. Choose the containers to be used for transplanting and fill them with soil. Poke holes in the center. Leave ½" at the top to insure proper watering.
2. Prepare the seedlings for transplanting. Loosen the seedlings in the plastic flat from the bottom. Be careful not to tear the root systems. Scoop the soil under the plants *with your hands* and gently raise the seedlings up and out of the flat.

   * Do not pull plants from the top. You will break the roots and the tops.
3. Pick one seedling at a time out from the bunch. Hold it by the top leaves, not the stem and place the roots in the hole.
4. Lightly, press the soil around the stem so it stands upright.

   When the job is complete, water them.

Suggested Materials

1. Seedlings, 2"-5" tall (flats of marigolds are extremely hardy)
2. Soil mix 1:1:1 soil:sand:perlite
3. Plastic containers, lightweight and unbreakable
4. Labels
5. Wax pencils

Special Considerations

If you are transplanting a large number of seedlings, it is usually recommended to use compartment containers. These containers (cell paks) are used commercially. They range in size from holding one plant up to 12. The individual cell paks fit nicely in the 11 x 22 flat (8 sixes/flat).

* As a general rule of thumb, as soon as seedlings show their first true leaves, it is time to transplant. In large greenhouse operations, the seedlings are more or less poked down into the hole so the making of the hole, placing the plant in the hole and pushing soil around the stem, is all done in one step. This might be something to work up to.

Another variation might have clients working in an assembly line, filling the cell paks with soil, another poking holes in the center of each cell, another placing the seedlings and pushing the soil around it. Finally, someone could water the flat as they are completed.

Grow-n-Green

TRANSPLANTING SEEDLINGS

Instructor's Guide

Possible Goals

Physical:	excellent for hand-eye coordination improvement
Cognitive:	repetition of a task, developing confidence
Emotional:	improving self concept, learning to be gentle

Review Questions for the Client

1. Why do we lift the seedlings from the bottom?
2. Why do we hold the seedling by the true leaves and not the stem?

Answers

1. We lift the seedlings out of flat from the bottom to reduce injury to the seedlings, pulling the plant from the top would result in broken roots.

2. Once the seedling is free from the others, we hold it by the leaves so we don't break or bruise the stem.

Grow-n-Green

LET'S REPOT IT!

Instructor's Guide

Brief Description

This activity increases the client's understanding that as the leaves and roots grow and develop, the plant must be repotted in a larger container to continue its healthy growth.

Procedure

1. Decide what size pot you will place the plant in. Generally, it is a good idea to take one inch larger than the previous pot. Break a clean old pot into pieces with a hammer and line the bottom of the new pot. Fill it 1/3 full with soil, leaving room for the plant.
2. Hold the plant with one hand and the pot with the other. Tap the pot on a hard surface to loosen the plant. This frees the plant and helps decrease root injury. Have fingers around the stem of the plant so it doesn't fall. Gently loosen the tips of the roots.
3. The plant should be perpendicular to and centered in the pot. Add soil by handfuls and fill almost to the top, leave 1/2" at the top so it can be watered properly.
4. Water and check bi-weekly.

Suggested Materials

1. Broken clay peices
2. Clean containers, clay or plastic pots
3. Plant that needs repotting
4. Soil mix
5. Water
6. Root bound plant for study

Special Considerations

Plants need to be placed in the proper sized pot for optimum growth. Explain to the client that plants need more room as their leaves and roots develop. If a plant is not repotted into a larger pot soon enough, the plant becomes root bound (show example). A root bound plant has roots growing in a circle, growing around and around inside the pot. This will retard the growth and eventually strangle the plant. After the plant has been tapped out of the pot, gently loosen the root tips so they will once again grow downward. If the plant is root bound, loosen the encircled roots so they hang fee.

After the plant has been repotted and watered, it may be necessary to add more soil to maintain the level (1/2" from the rim).



LET'S REPOT IT! Page 2

Instructor's Guide

Possible Goals

Physical: Acquire or improve fine motor control.
Acquire or improve gross motor control.
Develop hand-eye coordination.

Cognitive: Learning a new task; develop a sense of curiosity.

Emotional: Improve self concept--one needs to extend oneself to grow.

Review Questions for the Client

1. Why do you put broken pieces of clay in the bottom of a pot and then fill it with soil?

2. What happens to a plant if it is left in a pot that is too small?

Answers

1. You put the pieces of clay in the bottom to promote water drainage.

2. The plant becomes root bound; it won't grow and if left too long could die.

Grow-n-Green

TAKING A LEAF CUTTING

A PROPAGATION TECHNIQUE

Instructor's Guide

Brief Discussion

This activity involves learning several leaf cutting propagation techniques and understanding plants require special techniques.

Procedure 1 - African Violet

1. Fill containers with soil/sand mixture; poke a hole in the center of each, using the end of a pencil.
2. Take the leaf cutting. Cut off a small stem with the leaf blade attached. The leaf stem is called the petiole; the petiole is attached to the main stem.
3. Place the petiole in the hole. Firm soil around the stem.
4. Water carefully -- African violets do not like their leaf blades wet.

   * African violets don't respond well to wet leaves, so fill little jars with water; secure plastic wrap over the top with a rubber band. Poke a small hole through the plastic and insert the petiole into the water. Check to see if water level is above the bottom of the stem.

Procedure 2 - Begonia Rex

1. Fill a flat container with rooting medium.
2. Remove one leaf from the Begonia plant.
3. Make clean, small cuts through the veins of the underside of the leaf; two or three per vein.
4. Place the leaf (underside down) on the rooting medium.
5. Secure the leaf onto the medium with soil or toothpicks.

Procedure 3 - Sansevieria

1. Cut the long tapering leaves into sections, 3-4 inches in length.
2. Insert the leaf pieces 3/4 of their length into sand. After a period of time, a new plant forms at the base of the leaf section.

   * Cut the basal end of the section on an angle or slant to avoid confusion. Always plant the basal end.

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Possible Goals

Physical: Improve fine motor control.
Develop hand-eye coordination.

Cognitive: Develop a sense of curiosity. With every new plant there is something special about it. This is true with people also.

Emotional: Develop a sense of responsibility.
Delay gratification.

Review Questions for the Client

1. What section of plant did we use in propagating the Begonia?
2. Why do we use this technique anyway?
3. What does propagate mean?
4. What are some other ways to propagate?

Answers

1. We used just the leaf.
2. We use the leaf cutting technique to increase our plant supply. Say our plant has 20 leaf cuttings, we take those and grow them -- each of those has 20 leaves. We can increase our number of plants quickly.
3. The word propagate just means the act of taking cuttings to increase the plant supply.
4. The following are all propagation techniques: sexual propagation, seed germination and sprouting.
   Asexual propagation, stem cuttings, division, leaf, leaf bud and leaf petiole cuttings.

Suggested Materials

1. Rooting Medium

   Procedure 1 Sand, peat and soil 2:1:1, or water in jars
   Procedure 2 Sand
   Procedure 3 Sand

2. Containers

   Procedure 1 Flats or glass jars
   Procedure 2 Shallow flats
   Procedure 3 Pots or flats

Grow-n-Green

3. Miscellaneous propagation knive, labeling materials.

Procedure 1 Plastic wrap
Rubber bands

Procedure 2 Toothpicks or pins to secure the leaf to the medium

Considerations

These activities require numerous cutting actions. Various kinds of adapted tools are made to assist special populations with cutting exercises. For example, for persons with impaired vision can use scissors that are made with oversized bright yellow handles. in some cases, it might be imparative to assist your client in making the various cuts.

Procedure 1 Try an experiment; try rooting all of these parts of an African violet:

1) the leaf balde with petiole
2) the leaf blade only
3) a portion of the leaf blade

Given the proper care, each of these will develop new roots and shoots.

African violets grow well at home, however, they must be kept moist (watering from the bottom works best) and the fuzzy leaves must be kept dry of they will spot.

Procedure 2 Begonia Rex

The thick fleshy leaves of the Begonia must be mature in order for this tecnnique to be successful. A cut should be made perpendicular to the vein on the underside of the leaf blade. The leaf should be secured to the rooting medium with the natural upper surface of the leaf exposed This procedure requires high humidity and generally takes a long time. New plants will form at the point where the vein was cut.

Procedure 3 Sansevieria

Be sure to plant the basal end of the cutting. Sansevieria are extremely hardy.

Grow-n-Green

Instructor's Guide

SPROUTING AN AVOCADO

Brief Description

This activity helps the client become aware of a very large seed and practice an unusual germination technqiue.

Procedure

1. The client is instructed now to prepare the avacado seed for germination. The avocado germinates readily when the lower centimeter of the seed is removed. A clean cut should be made with a sharp propagation knife.
2. Wooden toothpicks are inserted into the flesh of the avocado, approximately half the distance from the pointed end to the flat end.
3. Place the avocado in a plastic cup; the bottom of the seed should be sitting low enough to be covered with water. Fill the cup with water, leaving only 1/2 cm at the rim.
4. Place the cup in a warm, dimly lit spot. Check daily for water; the water level should never get below the bottom of the seed.
5. Transplant the avocado seedling when the roots are strong and vigorous.

Suggested Materials

1. Clean avocado pits; soak to remove brown coat.
2. Wooden toothpicks-the longer and sturdier the better.
3. Clear plastic cups, cocktail size.
4. Sharp propagation knife.
5. Water

Special Considerations

The clean avocado seeds can be stored in a moist plastic bag up to two weeks. When slicing the seed with a sharp instrument, be sure to assist the client if there are any coordination problems. The avocado seed will take 3-5 weeks for germination. Observe root and leaf development as the roots develop.

* Experiment, from the initial stages of the activity. Put half of the cups with seeds in darkness and half in bright light. Label appropriately and observe the changes each make. Which cup (in the light or darkness) grew roots first? Once the roots developed, which cup grew the fastest?



Instructor's Guide

Possible Goals

Physical:	Fine motor, hand-eye coordination
Cognitive:	An understanding that all seeds, large or small require certain amounts of care to survive, and new life cannot form without environmental factors, water, light and warmth.
Emotional:	An awareness of life changing events, even when part of something, in this case the avocado pit, is cut away, it can survive and create something of value.

Review Questions

1. Why did we cut off the lower layer of the avocado pit?
2. Was the water level kept above the bottom of the seed?
3. How long did it take your seed to develop roots?

Answers

1. Removing the lower centimeter of seed flesh speeds up the rooting process.
2. Yes, the bottom of the avocado should be kept covered with water. Be sure to add water when necessary.
3. 3-5 weeks.

Appendix C

Basic Horticultural Knowledge Test (B.H.K.T.)

TEST QUESTIONS

Concept: TRANSPLANTING AND REPOTTING

Questions:

1. When transplanting, which is the best way to hold a seedling?
2. When is the best time to transplant?
3. How do you lift a seedling from the flat?
4. Which of these has been transplanted properly?
5. Which pot would this plant be repotted in?

Concept: PLANT ANATOMY AND GROWTH

Questions:

1. Where is the node?
2. Which of these happens first?
3. The bulk of the food is stored in the?
4. The protective layer around the seed is the embryo?
5. The function of the root is?

Concept: PLANT PROPAGATION

Questions:

1. Where is the best place to take a stem cutting?
2. Which of these is a leaf-petiole cutting?
3. Which of these is not a propagation technique?
4. What do we mean by the word propagate?
5. Why do we propagate plants?

Grow-n-Green

Grow + Know

1. I will read the questions out loud as you read them silently.
2. Please answer Each question, even if you do not completely understand all the words.
3. Mark only one answer for each question.
4. Please do your own work.
5. Please do your very best.

Your Name: _____

Are you A BOY ☐
A GIRL ☐

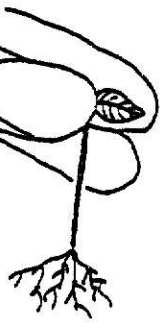
Your teachers Name: _____

Grow-n-Green

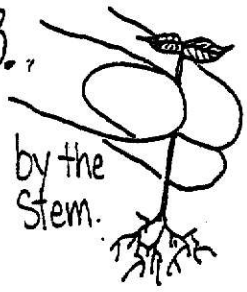
Grow & Know

1. Which is the best way to hold a seedling when transplanting? (circle one)

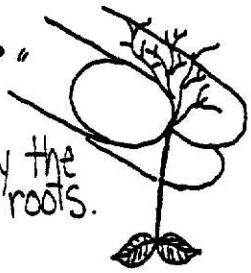
A. "By the leaves."



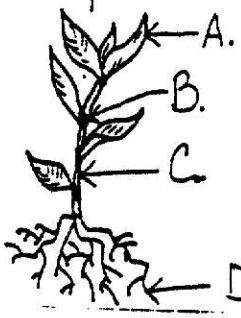
B. "by the stem."



C. "by the roots."



2. Which arrow points to the node on this plant?



Arrow _____ (letter) points to the node.

3. What does the word PROPAGATE mean?

A. It is where the food is stored in the plant.
B. To grow new plants from cuttings.
C. To supply a plant with nutrients and minerals.
D. The point where the leaf is attached to the stem.

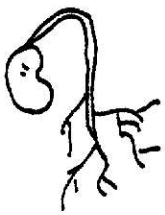
Grow-n-Green

Grow + Know

4. When is the best time to transplant a Seedling?
   A. Before the roots develop.
   B. When the first true leaves appear.
   C. When the plant is root-bound.

5. Which of these happens FIRST in Seed Germination?

A. 

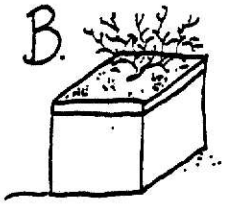
B. 

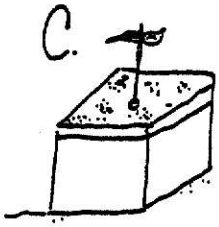
C. 

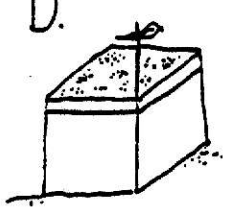
6. Which one of these is NOT a propagation technique?
   A. Stem cuttings
   B. planting seeds
   C. leaf Cuttings
   D. tree pruning

7. How should a plant look if it has been transplanted properly?

A. 

B. 

C. 

D. 

Grow-n-Green

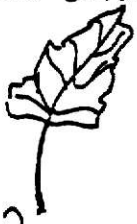
GROW + KNOW

8. Most of the food in a Seed is stored in (Circle one)
   - A. The seed coat
   - B. The Endosperm
   - C. The Nucleus
   - D. The Embryo

9. Which of these show a leaf-petiole cutting?

A. 

B. 

C. 

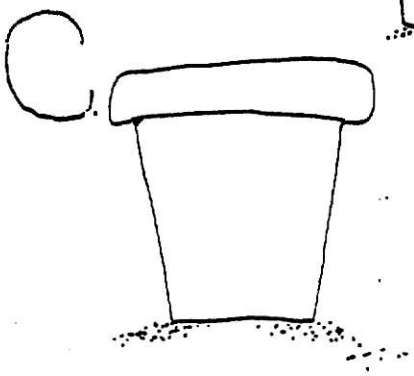
10. What is the function of a Root?
    - A. To produce Seeds
    - B. To absorb water and minerals
    - C. To absorb light

11. Which pot would this plant be RE-POTTED in?



A. 

B. 

C. 

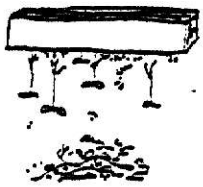
Grow-n-Green

Grow & Know

12. Why do we propagate plants?
    A. To reduce insects.
    B. To increase the plant supply.
    C. To make the plants greener.

13. The protective layer around the seed is the Embryo?
    A. True B. FALSE

14. Which is the best way to remove a bunch of seedlings from a flat?
    A. pull by the leaves and stems.
    B. Dump flat up-side-down.
    C. Scoop from the bottom.


15. Where on the Plant is the best place to cut the plant when we take a stem cutting?
    A. On the stem, above the node.
    B. On the stem, below the node.
    C. on the stem, through the node
    D. Trough the tip of the leaf.

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Appendix D

Teacher and Student Evaluation Forms

Tell Me What You Think !

1. Did you like learning about plants?

yes_____ no_____

Why or Why not_____

_____.

2. Which Activities did you like the best?
(place a check next to those you liked)

___ Avocado sprouting
___ Seed pictures
___ leaf Cuttings
___ transplanting
___ Repotting
___ sprouting beans
___ stem cuttings
___ germinating seeds

3. List the Activities you did not like._____

_____.

Why didn't you like them?_____

_____.

4. Would you like to do More plant projects?

yes_____ no_____

5. What <u>other</u> plant projects would you like to do?

_____

_____.

6. Explain one thing you learned from an Activity.

_____

_____

_____.

7. Did you understand the directions for the Activities? YES_____ No_____.

8. Did the pictures help explain what to do?
YES_____ No_____

9. Which Activity was the Most difficult?

_____.

10. Is there anything else you want to tell me?

_____

_____

_____

_____

Thank you

Grow-n-Green

EVALUATION SHEET

Activity 1-8	Name of Activity
1	What is a Seed? (seed pictures)
2	Sprouting a seed. (bean seed)
3	Germinating seeds. (seeds in small flats)
4	Taking a stem cutting.
5	Transplanting seedlings.
6	Sprouting an avocado.
7	Repotting. (green pepper)
8	Taking a leaf cutting

1. Please rate the Activity Sheets #1-8 as to their level of clarity (1=unclear, 2=clear, 3=very clear) for the instructor's guide and the Grow-N-Green activity sheets (A) as you the instructor saw them and (B) as to the level of clarity for the children. Please circle the number representative of the level of clarity.

Activity #	Instructor's Guide	Grow-N-Green Activity Sheets To Instructor	To Children
1	1 2 3	1 2 3	1 2 3
2	1 2 3	1 2 3	1 2 3
3	1 2 3	1 2 3	1 2 3
4	1 2 3	1 2 3	1 2 3
5	1 2 3	1 2 3	1 2 3
6	1 2 3	1 2 3	1 2 3
7	1 2 3	1 2 3	1 2 3
8	1 2 3	1 2 3	1 2 3

2. Please list any other horticultural activities that could be done?

   by you _____. Ideas: _____

   children _____. Ideas: _____

3. Were the drawings and illustrations appropriate? _____. Too detailed? _____ Confusing? _____

   Please comment on what improvements should be made for each activity. (activities 1-8)



4. What were the most significant experiences or concepts that you felt the children learned by these activities?

5. Do you feel the activities were directed to the correct age level?

   Yes_____ No_____ Younger?_____ Older?_____

   Which activities (1-8) should be adjusted for use with a 4th grade class. Please explain.

6. If these activities were available to you as a teacher, would you use them in your lesson planning? Yes_____ No_____

   Do you feel other teachers would use these? Yes_____ No_____

7. Other comments please.

THANK YOU FOR YOUR TIME !!

Teacher and Student Evaluations:

Two separate evaluations forms were written to obtain information from teachers and students. The teachers evaluation form measured the teacher's opinion of the effectiveness of the "Grow-N-Green" series and Teacher Guides. The student form was completed by each student in the experimental groups at the termination of the study. The students were asked to identify favorite, least favorite and most difficult activities.

Teacher Evaluation Results:

As shown in Table A-1, the overall rating for the material was high for the clarity both to the instructor and to the children. Activity #8, Taking a Leaf Cutting, was the most complex activity and could be simplified by reducing the number of procedures.

In response to question #2, teachers suggested the use of other seeds and plants materials but not specific activities. Question #3 was answered affirmatively by all teachers, indicating the illustrations were appropriate. In response to question #4, the teachers thought that the most significant experiences or concepts gained by the student were "actual hands-on experience" in learning various ways to propagate plants, learning about seeds and cultural aspects of plants. The hands-on learning experience was noted by Allen (16) as a way to spark enthusiasm in elementary age children. All teachers thought the activities were directed to the appropriate grade level (#5). They also indicated that they would use the "Grow-N-Green" teaching series if it were available. All other comments were positive and summed up by one teacher; "the children were given a hands-on approach to plant life. This type of

learning seems to work the best with this age level. They (the students) experienced all stages of plant growth, increased their vocabulary (and retained it!) and even had a feeling of success or defeat, when their plant either survived or died.

Student Evaluation Results:

All 67 children indicated that they liked learning about plants. As shown in Table A-2, the three most popular activities overall were (1) "Transplanting a Seedling", (2) "Let's Sprout a Seed", and (3) "Germinating a Seed"; these were also rated highest by the girls. The boys favored the stem cutting, transplanting and sprouting a seed activities. When the children were asked which activity they did not like and why, the most frequent activity listed was "Sprouting an Avocado", because it was "too hard" and "it did not work". Sixty-six children stated that they would like to do more plant related projects. The most requested projects for future classtime were (1) planting flowers (roses and sunflowers), (2) planning and planting a garden, and (3) pruning trees. The students explained one concept they learned from participating in the series of activities. They responded "I learned that when a plant has no where for the roots to grow it is rootbound, and needs repotting," ; "I learned where the seed coat is and it protects the bean", "I learned to hold a plant by the true leaves, not the stem", and "I learned new words like germination". Sixty of the 63 students who responded said that they did understand the directions, and they all stated that the illustrated pictures helped clarify the directions. The activity rated most difficult and also most popular was "Transplanting a Seedling".

Table A-1

Teacher and Student Evaluation Summary.

	Rating of Clarity**		
	Teacher Guides	"Grow-N-Green" Activities	
Activity	Teachers	Teachers	Students
1. "What is a Seed?"	3.0	3.0	3.0
2. "Sprouting a Seed "	3.0	3.0	2.2
3. "Germinating Seeds"	3.0	3.0	3.0
4. "Taking a Stem Cutting"	3.0	3.0	3.0
5. "Transplanting Seedlings"	3.0	3.0	3.0
6. "Let's Sprout an Avocado!"	3.0	3.0	3.0
7. "Let's Repot It!"	3.0	3.0	3.0
8. "Taking a Leaf Cutting"	2.2	2.2	3.0
Averages--	2.9	2.9	2.9

**Rating: 1 = unclear; 2 = clear; 3 = very clear

Table A-2

Student Preference: Eight "Grow-N-Green" Activities.

Activity	Boys	Girls	Total Votes
1. "Transplanting Seedlings"	20	32	52
2. "Sprouting a Seed"	20	31	51
3. "Germinating Seeds"	19	32	51
4. "Let's Repot It!"	19	30	49
5. "Taking a Stem Cutting"	21	26	47
6. "Let's Sprout an Avocado!"	15	28	44
7. "Taking a Leaf Cutting"	16	27	43
8. "What is a Seed?"	15	26	41

Appendix E

ANOVA Summary Table

Table A-3

Analysis of Variance Summary Table for Net Scores of Children Completing "Grow-N-Green" Horticultural Teaching Aids.

Concept	Source of Variance	Sum of Squares	F	P > F
Total Basic Horticultural Knowledge	TRT	708.528	F (2,92) = 64.09	p < .0001
	TRT*SCHL	78.137	F (2,92) = 7.07	p < .001
Plant Anatomy	TRT	78.309	F (2,92) = 26.86	p < .0001
	SEX*TRT	10.089	F (2,92) = 3.46	p < .04
	TRT*SCHL	37.306	F (2,92) = 12.80	p < .0001
Plant Propagation	TRT	79.383	F (2,92) = 22.19	p < .0001
	SEX*TRT	12.176	F (2,92) = 3.40	p < .04
Plant Growth & Development	TRT	79.532	F (2,92) = 28.30	p < .0001

CHILDREN AND HORTICULTURE: CONSTRUCTION AND EVALUATION OF ILLUSTRATED HORTICULTURAL TEACHING AIDS

BY

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B.S., University of Missouri, 1979

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Horticulture

Kansas State University
Manhattan, Kansas

1982

Abstract:

Eight illustrated horticultural teaching aids, covering three basic concepts in horticultural knowledge, were prepared for utilization with fourth grade students. Eight teacher guides were written for the teacher as a supplement to the step-by-step procedures. The eight teaching aid activities and the teacher guides were titled "Grow-N-Green" and their effectiveness determined with 59 female and 45 male children enrolled in six fourth grade classes in two public schools.

A graphically drawn multiple choice Basic Horticultural Knowledge Test (B.H.K.T.) was developed to assess the knowledge gained through implementation of the "Grow-N-Green" teaching series. The fifteen item test had five questions for each of the three concepts covered in the teaching aids: (1) Plant Anatomy, (2) Plant Growth and Development, and (3) Plant Propagation.

Pre- and post-test B.H.K.T. scores were analyzed for the three treatments: (1) horticultural teaching aids with teacher supervision, (2) horticultural teaching aids with student self-directed study, and (3) control, students continuing with scheduled classwork. The students using the "Grow-N-Green" series with teacher supervision had significantly higher scores than the other treatments. However, student self-directed study also significantly increased learning of some basic horticultural concepts.

Boys and girls learned similarly the horticultural concepts in teacher assisted classes. Boys scored significantly higher in self-directed study than girls in plant anatomy concepts. The study indicated that fourth grade urban school children's knowledge of horticultural concepts was inadequate (40%), but increased significantly (22% increase) during the four weeks of teaching. "Grow-N-Green" teaching aids or similar horticultural training should be taught in public schools.